

REMARKS

This amendment is responsive to the Office Action dated September 23, 2005. Claims 1 – 90 are pending in this application. Claims 15 - 20, 39 - 48, 69 – 80, 89 and 90 are withdrawn from consideration and are herein canceled. Claims 1 – 14, 21 – 38, 49 – 68, and 81 – 88 are rejected. Reexamination is respectfully requested in view of the foregoing amendments and following remarks.

Election/Restrictions

The non-elected claims have been canceled as required.

Specification

The title has been amended to reflect the inventions now claimed.

Claim Rejections Under 35 USC § 103

In the Office Action, the Examiner has referred to Yasutimi et al. (JP 2001-339100). The name of the inventor is incorrect on the Abstract. The correct name is "Adomi". Throughout this response the reference is referred to as '339100 to eliminate ambiguity.

Claim 1 has been further restricted as having a configuration in which the

light-emitting-layer-portion-side Ag-base contact layer is arranged between the compound semiconductor layer, which has a light-emitting layer portion, and the Ag-base reflective metal layer.

The Ag-base reflective metal layer composes a portion of a current supply path to the light emitting layer portion. Direct bonding of the Ag-base reflective metal layer to the light emitting layer portion composed of a compound semiconductor, however, may increase the contact resistance, and may increase the series resistance, and may thereby lower the emission efficiency. For the case with the Ag-base reflective metal layer, it is made possible to adopt the Ag-base contact layer, rather than the conventionally-used Au-base one, so that this is not only beneficial in lowering the contact resistance similarly to the Au-base one, but also in lowering the costs for forming the contact layer as compared with the case where the Au-base contact layer is used. The Ag-base contact layer is also less likely to absorb light in shorter wavelength regions, unlike the Au-base contact layer.

Carter-Coman does not disclose materials composing the ohmic contact 32, so that it is of course impossible to teach a concept of configuring it by the light-emitting-layer-portion-side Ag-base contact layer. '339100 does not use the Ag-base reflective metal layer, and of course gives no disclosure on the light-emitting-layer-portion-side Ag-base contact layer. Claim 1 as amended and dependent Claims 2, 3, 5, 6, 7, 8 and 9 are, therefore, not taught or suggested by Carter-Coman and '339100.

Claim 10 has been further restricted so that a material composing the Ag-base reflective metal layer is a Pd-containing Ag alloy. The Pd-containing Ag alloy is excellent in the anti-sulfurization and anti-oxidation properties, and effective in preventing sulfurization- or oxidation-induced lowering in the reflectivity. Carter-Coman gives no disclosure on configuring the Ag-base reflective metal layer using the Pd-containing Ag alloy at all. '339100 does not use the Ag-base reflective metal layer. Claim 10 as amended is, therefore, not taught or suggested by '339100 and Carter-Coman.

Claim 11 has been further restricted as having a configuration in which a conductive semiconductor substrate is used as the device substrate, and the substrate-side Ag-base contact layer having Ag as a major component is formed between the device substrate and the Ag-base reflective metal layer. This makes it possible to lower the contact resistance between the substrate and the Ag-base reflective metal layer, and also to configure the device at low costs because the Au-base contact layer is unnecessary.

Carter-Coman gives no disclosure on provision of the substrate-side, Ag-base contact layer between the device substrate and the Ag-base reflective metal layer. '339100 does not use the Ag-base reflective metal layer, and of course gives no disclosure on the substrate-side Ag-base contact layer. Claim 11 as amended and dependent Claims 12 and 13 are, therefore, not taught or suggested by Carter-Coman and '339100.

Claim 21 is substantially common with Claim 1 as originally filed in the

essential portion thereof, in which the Ag-base contact layer based on the same concept with the light-emitting-portion-side Ag-base contact layer is provided between the main back surface of the light emitting layer portion or the transparent compound semiconductor layer, and the Ag-base reflective metal layer (it is to be noted that the emission peak wavelength is limited to 450 to 580 nm, both ends inclusive). When a dopant element used for forming the ohmic contact is alloyed, together with Ag, with a compound semiconductor, the ohmic contact property with the Ag-base reflective metal layer is extremely improved. The contact layer herein is formed as an alloy layer having a large Ag content, so that it is made possible to further raise the extraction efficiency of light having a peak wavelength from 450 nm or above to 580 nm or below, that is, the light ranging from blue to green, as compared with a conventional contact layer composed of a simple element such as Ni, Co, Mg, Sb and so forth.

Carter-Coman gave no disclosure on materials composing the ohmic contact 32, so that it is of course impossible to find out a concept of configuring it by the Ag-base contact layer. '339100 does not use the Ag-base reflective metal layer, and of course gives no disclosure on the Ag-base contact layer. Claim 21, as amended and dependent Claims 23 to 29, as well as claim 30 having the subject matter of Ag-base contact layer, are, therefore, not taught or suggested by Carter-Coman and '339100.

Claim 31 as originally filed was further restricted as having a configuration in which the substrate-side contact metal layer, reducing the contact resistance

between the device substrate and the diffusion-blocking layer, is interposed between the diffusion-blocking layer and the device substrate. This makes it possible to lower the contact resistance between the diffusion-blocking layer composed of a conductive material and the device substrate, and to effectively suppress excessive rise in the series resistance and forward voltage of the light emitting device, despite the diffusion-blocking layer being additionally interposed. It is to be noted that the substrate-side contact metal layer cannot fully express the contact resistance reducing effect between itself and the device substrate, when interposed between the main metal layer and the diffusion-blocking layer.

Carter-Coman discloses the diffusion-blocking layer directly bonded to substrate 38, so that it is absolutely impossible to find out a concept of disposing the substrate-side bonding metal layer between the diffusion-blocking layer and the device substrate, anywhere in the specification or attached drawings. '339100 does not use the Ag-base reflective metal layer, and also gives no disclosure on the provision of the substrate-side contact metal layer between the diffusion-blocking layer and the device substrate. Claim 31 as amended and dependent Claims 33 to 37 are, therefore, by no means rejected on the basis of Carter-Coman and '339100.

Claim 38 was further restricted as having a configuration in which the device substrate is an Si substrate, and with respect to the main metal layer, a portion thereof including the interface with the diffusion-blocking layer is composed of an Au-base metal layer, and a portion thereof forming the compound-

semiconductor-layer-side reflective surface is composed of an Ag-base layer. Use of the Ag-base layer for the portion forming the reflective surface makes it possible to raise the reflectivity with respect to the flux of emitted light, and use of the Au-base metal layer, which is soft and readily bondable, on the side brought into contact with the diffusion-blocking layer makes it possible to readily bond, while placing the main metal layer in between, the compound semiconductor layer and the diffusion-blocking layer on the device substrate side. Provision of the diffusion-blocking layer in between is particularly beneficial, because the Au-base metal layer and the Si substrate are likely to form eutectic crystal.

Carter-Coman discloses only a single Ag layer as the main metal layer, and gives no disclosure on a concept of disposing the Au-base metal layer on the diffusion-blocking-layer side anywhere in the specifications or attached drawings. '339100 gives no disclosure on provision of the Ag-base layer on the reflective layer side. Claim 38 as amended is, therefore, not taught or suggested by Carter-Coman and '339100.

In claim 49, metals composing the reflective metal layer were restricted to those having any one of Ru, Rh, Re, Os, Ir and Pt as a major component. Ru, Rh, Re, Os, Ir and Pt have reflectivity equivalent to that of Ag, and raises no fear of sulfurization- or oxidation-induced degradation in the reflectivity, unlike Au.

Carter-Coman and '339100 disclose only a single Ag layer as the main metal layer, and give no disclosure on a concept of composing the reflective metal layer with a metal having any one of Ru, Rh, Re, Os, Ir and Pt as a major

component, anywhere in the specification and the attached drawings. Claim 49 as amended and dependent Claim 50 are, therefore, not taught or suggested by Carter-Coman and '339100.

Claim 63, as originally filed, was further restricted as having a configuration in which the reflective metal layer is the Ag-base reflective metal layer claimed in Claim 59, as originally filed, and as providing a protective metal layer between the Ag-base reflective metal layer and the light emitting layer portion. Provision of the protective metal layer makes it possible to effectively prevent oxidation and sulfurization of the Ag-base reflective metal layer.

Carter-Coman gives no disclosure on a concept of providing such protective metal layer, anywhere in the specifications or attached drawings. '339100, using no Ag-base reflective metal layer, intrinsically raises no need of providing the protective metal layer. Claim 63 as amended and dependent Claims 64 and 65 are, therefore, by no means rejected on the basis of Carter-Coman and '339100.

Claim 66, as originally filed according to which the reflective metal layer is composed of a metal having any one of Ag, Ru, Rh, Re, Os, Ir and Pt as a major component, was further restricted as having a configuration in which the reflective metal layer is bonded to the device substrate composed of a semiconductor, while placing the binding-use metal layer having Au as a major component in between. The binding-use metal layer having Au as a major component is less susceptible to oxidation and so forth, and can more readily ensure the necessary binding force with the device substrate. In particular for the case where the device substrate is

configured using a Si substrate, use of the Au-base metal layer as a binding-use metal layer makes it possible to generally lower the contact resistance with the Si substrate.

Carter-Coman discloses only a single Ag layer as the main metal layer, and gives no disclosure on a concept of disposing the Au-base metal layer on the diffusion-blocking-layer side anywhere in the specification and the attached drawings. '339100 gives no disclosure on provision of the Ag-base layer on the reflective layer side. Claim 66 as amended and dependent Claim 68 are, therefore, not taught or suggested by Carter-Coman and '339100.

According to claim 81 as originally filed, Si-diffusion-blocking layer is configured as having Au or Ag as a major component and as containing a Si-diffusion-blocking component which comprises a single, or two or more elements selected from Sn, Pb, In and Ga. These four elements composing the Si-diffusion-blocking component produce a strong repulsion potential with respect to Si atom in a solid state, show a solid solubility limit into Si almost close to zero as indicated by the phase diagram, and thus exert a large inhibiting effect on the Si diffusion. Au or Ag in a form of single component suffers from a relatively large diffusion coefficient with respect to Si at the bonding temperature (100°C to 500°C, both ends inclusive) described later, but addition thereto of an appropriate amount of these Si-diffusion-blocking components can successfully reduce the Si diffusion to a considerable degree.

Neither Carter-Coman nor '339100 disclose such Si-diffusion-blocking layer

containing Sn, Pb, In or Ga. Claim 81 and dependent claims 82 – 88 are, therefore, not taught or suggested by Carter-Coman and '339100.

In view of the foregoing, it is respectfully submitted that the application is now in condition for allowance, and early action in accordance thereof is requested. In the event there is any reason why the application cannot be allowed in this current condition, it is respectfully requested that the Examiner contact the undersigned at the number listed below to resolve any problems by Interview or Examiner's Amendment.

Respectfully submitted,



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